

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

Message Exchanger

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0050236.5

1 **CROSS-REFERENCE TO RELATED APPLICATIONS**

2 This application claims priority from U.S. Provisional Patent Application
3 Serial No. _____ entitled "XML Object Access Protocol" filed on August 10,
4 1999, and from U.S. Provisional Patent Application Serial No. _____ entitled
5 "_____" filed on March __, 2000.

6
7 **TECHNICAL FIELD**

8 This invention relates to a mechanism for formatting messages and
9 exchanging them between entities in a decentralized, distributed networking
10 environment.

11
12 **BACKGROUND**

13 HTML (HyperText Markup Language) document encoding has proven to
14 be flexible and useful on the Internet for viewing documents. The World Wide
15 Web ("Web") has grown popular in large part to HTML's graphical representations
16 of data and its links to other data.

17 HTML is a specific implementation of a SGML (Standard Generalized
18 Markup Language). SGML is a generic text formatting language that is widely
19 used for large databases and multiple media projects. It is particularly well suited
20 for works that involve intensive cross-referencing and indexing. HTML is an
21 application of SGML. It uses tags to mark elements, such as text and graphics, in
22 a document to indicate how Web browsers should display these elements to the
23 user and should respond to user actions. Such an action may be an activation of a
24 link by means of a key press or mouse click.
25

1 XML (eXtensible Markup Language) is a specific implementation of a
2 condensed form of SGML. XML lets Web developers and designers create
3 customized tags that offer greater flexibility in organizing and presenting
4 information than is possible with the HTML document encoding system.

5 In HTML, both the tag semantics and the tag set are fixed. XML specifies
6 neither semantics nor a tag set. In fact, XML is really a meta-language for
7 describing markup languages. In other words, XML provides a facility to define
8 tags and their structural relationships. This facility may be called a "grammar."
9 Since there is no predefined tag set, there is not any preconceived semantics or
10 grammar. The semantics and grammar of an XML document is defined by the
11 applications that process them.

12 As the Internet is becoming a serious business tool, HTML's limitations are
13 becoming more apparent. For example, HTML can be used to exchange
14 presentation data (such as images and text), but it is not capable of exchanging
15 data messages (such as those containing commands, instructions, requests, or
16 complex business documents) conveniently. In message-oriented programming, a
17 message is the way that one program entity requests an action from another entity.
18 Typically, a message specifies the name of the entity or service to which the
19 request is made, the action (or method) to be performed, and any parameter or
20 value that needs to be specified for this request. Therefore, a "message exchange"
21 is a communication in which an entity sends a message to another entity to request
22 that the other entity take some action and, if appropriate, respond. An entity may
23 be a person, program object, an application, an operating system, a computer, a
24 computer system, a network, and so forth.

SCANNING

1 Message exchanges between entities are important to a distributed
2 computing environment where computers actively distribute work and data across
3 a network. Such distributed computing environments are common for "private"
4 networks, such as LANs and WANs. These private networks support message
5 exchange protocols (MEP). For example, RPC (Remote Procedure Call) is a
6 common MEP.

7 Typically, these private networks support message exchanges between
8 entities using the same platform. For example, a group of computers using a
9 variety of the Microsoft® Windows® operating systems on a network may easily
10 exchange messages using their native MEP. Likewise, a group of computers each
11 using the same "unix"-based network may easily exchange message using their
12 native MEP.

13 However, exchanging messages across heterogeneous platforms is difficult
14 to implement. If possible, such message exchanges typically require translation
15 and conversion between MEPs. Moreover, exchanging messages over a "public"
16 network is more difficult to implement. A "public" network (like the Internet)
17 includes multiple platforms that may or may not allow the exchange of messages
18 using a specific MEP. Additionally, it may be difficult or impossible to predict
19 MEP in advance.

20 While HTML is valuable for transmitting presentation data (such as images
21 and text) over the Internet for human viewing, it does not have the capability to
22 conveniently exchange data messages between entities (e.g., program modules)
23 over the Internet. Using HTML to transmitting a document from one entity to
24 another is not "message exchange" as understood by those skilled in the art of
25 message-oriented programming. Instead, one entity (such as a Web server) is

1 simply delivering data to be displayed to another entity (such as a Web browser)
2 and this other entity is not acting upon such data. The Web server cannot request
3 that the browser perform some task based upon the delivered data. The Web
4 server has no control over what the browser does with the delivered data.

5 Sometimes the delivered data includes a small program ("applet") using a
6 programming language such as Java. This is not "message exchange" as
7 understood by those skilled in the art of message-oriented programming. The Web
8 server simply delivers the applet, but it cannot cause it be run on the browser.
9 Note that delivery of the applet is not a request for the browser to perform a
10 specific function.

11 HTML is a format used for exchanging presentation data meant for human
12 consumption. The web-server sends HTML to the web-browser that renders it for
13 human consumption. In other words, HTML tags are the commands and hints to
14 the web-browser on how to render the presentation data.

15 HTML and similar protocols are not primarily targeted as a mechanism for
16 program-to-program communication that may not involve any human interaction
17 at all. Communicating programs/entities typically agree on the commands and the
18 associated data. A Java applet involves code download and local execution. It is
19 not designed for program-to-program communication.

20 XML provides flexibility extensibility and specificity that HTML and other
21 protocols do not. Thus, it is possible to use XML to exchange data messages over
22 a public or private network. However, no defined protocol for exchanging
23 messages using XML presently exists.

SUMMARY

Using a message exchanger, data messages are exchanged between entities in a decentralized, distributed, potentially heterogeneous, network environment. The message exchanger employs XML (extensible Markup Language). To accomplish this, the entities on both ends of the message exchange understand, identify, and parse the message format.

The message exchanger defines such a mechanism. Data messages are broken down into two portions—one portion (the body) is intended from an ultimate destination and the other portion (the header) is intended for intermediate destination and/or the ultimate destination. The body may be defined so that it must be understood by the ultimate destination. The header may be defined so that it must be understood or changed. Regardless, the data in the body is delivered intact to the ultimate destination.

The message exchanger defines a message envelope exchange format in XML over a transport protocol, such as HTTP (HyperText Transport Protocol). This format allows for the execution of RPC (Remote Procedure Call) over XML, but it can be used for any message exchange over a network. The basic format (i.e., grammar) of the message envelope is:

```
<Envelope>
  <Header>
    header data (such as security and routing information
    or any other data)
  </Header>
  <Body>
    body data (such as a data structure or a request to
    perform some action or some other "method invocation")
  </Body>
</Envelope>
```

1 To send this message over HTTP on the Internet, special HTTP bindings
2 are employed. However, this format can be used with other transport protocols.

3 Also, there is a mechanism for returning error code return from the receiver
4 if the receiver is unable to satisfy the request. The format is the same as above
5 except body contents are specified to include a fault information structures.

6 7 **BRIEF DESCRIPTION OF THE DRAWINGS**

8 Fig. 1 is a schematic illustration of an exemplary computer network (such
9 as the Internet) that includes two computer entities.

10 Fig. 2 is a textual illustration of a message format implemented using the
11 exemplary messaging exchanger.

12 Fig. 3 is flowchart showing a process implementing the exemplary
13 messaging exchanger.

14 Fig. 4 is flowchart showing another process implementing the exemplary
15 messaging exchanger.

16 Fig. 5 is flowchart showing process implementing an alternative messaging
17 exchanger.

18 Fig. 6 is an example of a computer capable of implementing the exemplary
19 messaging exchanger.

20 21 **DETAILED DESCRIPTION**

22 The following description sets forth a specific embodiment of the message
23 exchanger that incorporates elements recited in the appended claims. This
24 embodiment is described with specificity in order to meet statutory written
25 description, enablement, and best-mode requirements. However, the description

1 itself is not intended to limit the scope of this patent. Rather, the inventors have
2 contemplated that the claimed message exchanger might also be embodied in other
3 ways, in conjunction with other present or future technologies.

4 5 **Incorporation by Reference**

6 The following provisional applications are incorporated by reference
7 herein: U.S. Provisional Patent Application Serial No. _____ entitled "XML
8 Object Access Protocol" filed on August 10, 1999, and U.S. Provisional Patent
9 Application Serial No. _____ entitled "_____" filed on March __, 2000.

10 **Introduction**

11 The exemplary message exchanger (herein embodiments of such message
12 exchanger may be called: "message formatter," "message sender," "message
13 parser," "message receiver," or the like) are implemented by one or more
14 computer entities on a communications network. The exemplary message
15 exchanger provides a simple and lightweight mechanism for exchanging messages
16 between entities in a decentralized, distributed network environment. The
17 exemplary message exchanger exchanges messages using Simple Object Access
18 Protocol (SOAP) that utilizes eXtensible Markup Language (XML) for data
19 formatting.

20 The exemplary message exchanger does not itself define any application
21 semantics or grammar such as a programming model or implementation-specific
22 semantics; rather it defines a simple mechanism for expressing application
23 semantics by providing a modular messaging packaging model. This allows the
24 exemplary message exchanger to be used in a large variety of systems ranging
25

1 from general messaging systems to message-oriented programming systems to
2 Remote Procedure Calls (RPC).

3 The exemplary message exchanger envelope construction defines an overall
4 framework (i.e., grammar and semantics) for expressing what is in a message; who
5 should deal with which parts, and whether parts are optional or mandatory.

6 Fig. 1 shows two computers 22, 24. These computers are connected to each
7 other via a computer network 26. These computers may be desktop, laptop,
8 handheld, server, or mainframe computers. These computers may be capable of
9 connecting to a communications network and exchanging messages. The network
10 26 may be a private network or a public network (e.g., the Internet).

11 Herein, an entity is understood to be a computer component that is capable
12 of exchanging messages in an message-oriented, decentralized, distributed
13 network environment. For example, an entity may be a computer, a computer
14 system, a component of a computer, or an application running on a computer.

15 Using the message exchanger, messages may be exchanged between
16 entities (such as applications running on computers 22 and 24) in a decentralized,
17 distributed network environment. The exemplary message exchanger employs
18 XML (eXtensible Markup Language).

19 The exemplary message exchanger defines such a mechanism for the
20 entities at both ends of the message exchange to understand, identify, and parse the
21 message format. In this exemplary embodiment, it specifically defines a message
22 envelope exchange format in XML and a transport binding over HTTP. However,
23 other protocols may be used, such as TCP/IP, UDP, SMTP, POP3, and the like.
24 This format allows for the execution of RPC (Remote Procedure Call) over XML,
25 but it can be used for any message exchange over a network.

1 Herein, an entity generating and sending a message is an "originating"
2 entity (i.e., originator). An entity that is the ultimate destination of a message is a
3 "destination" entity (i.e., ultimate destination). An entity sending a message is a
4 "sending: entity (i.e., sender). An entity receiving a message is a "receiving" entity
5 (i.e., recipient). An entity receiving a message, but is not the ultimate destination,
6 is an "intermediate" entity (i.e., intermediary). Furthermore, a message intended
7 for a subsequent destination entity may be received by an intermediate entity
8 wherein such message may indicate that the intermediate entity should take some
9 action. Such an intermediate entity may be referred to as the "actor" entity.

10 Message Envelope Format

11 Using the exemplary message exchanger, the message is an XML document
12 that consists of a message envelope, a header, and a body. This exemplary XML
13 document is simply called the "message" for the rest of this document. Fig. 2
14 shows the basic format of a message. The message contains the following:

15 As shown in Fig. 2, a message envelope 50 is the top hierarchical element
16 of the message.

17 Inside the envelope 50 is a header 60. The header is a mechanism for
18 adding features to the message in a decentralized manner with or without prior
19 agreement between the communicating entities. The message may include
20 attributes that indicate who (which entity) should deal with a feature and whether
21 it is optional or mandatory.

22 Also, inside the envelope 50 is a body 70. The body is a container for
23 commands and data intended for the ultimate recipient of the message (the
24 destination entity).
25

1 ENVELOPE: The envelope is the package containing the message itself. In
2 Fig. 2, the overall envelope is shown at 50. A beginning tag 52 and an ending tag
3 54 define the boundary of the envelope. The title "Envelope label" used in the
4 tags is a label used to indicate and identify that it is a message envelope. The
5 actual label used may be anything that means something to the specific
6 implementation of the message exchanger. For example, the label may be
7 "Envelope", "Message", "Package", "Command", and "MSG".

8 The beginning tag 52 may also include a reference to another entity that
9 defines the format of the message for the receiving entity. Alternatively, it may
10 include a reference to one of a set of existing format definitions. These format-
11 defining references may be called the schema definitions.

12 For more information on schemas, refer to World Wide Web Consortium's
13 (W3C's) document "XML Schema Part 0: Primer" at
14 <http://www.w3.org/TR/TR/xmlschema-0>. For more information on namespaces,
15 refer to the W3C's document "Namespaces in XML" at
16 <http://www.w3.org/TR/1999/REC-xml-names-19990114>.

17 The tags themselves are encoded by using an XML tag convention of angle
18 brackets (" $<$ " and " $>$ ") to designate the boundaries of a tag enclosing the label of
19 the tag and various optional attributes. The ending tag is identified using another
20 XML tag convention of a forward slash (" $/$ ") immediately after the open angle
21 bracket (" $<$ ") and before the label. Herein, these conventions are collectively
22 known as the "XML tag convention." More details of such a convention may be
23 found in the W3C XML 1.0 specification.

24 HEADER: As shown in Fig. 2, the header 60 is positioned immediately
25 after the envelope's beginning tag 52. A beginning header tag 62 and an ending

1 header tag 64 define the boundary of the header. These tags use the XML tag
2 convention and the "header label" is used to indicate and identify that it is a header
3 in the envelope. The actual label used may be anything that means something to
4 the specific implementation of the message exchanger. For example, the label
5 may be "Header", "Pre-body", "Preamble", "Intro", or "Prelim."

6 The header provides a flexible mechanism for extending a message in a
7 decentralized and modular way without prior knowledge between the
8 communicating parties. Typical examples of extensions that can be implemented
9 within header data 66 are authentication, transaction management, payment, etc. In
10 Fig. 2, the header data 66 is located between the header tags 62, 64.

11 All immediate child elements of the header data are called header entries
12 (i.e., element) and each header entry is encoded as an independent element within
13 the header data.

14 Generally, the header data 66 affects how a receiving entity processes the
15 message. The data that affects how a receiving entity processes the message may
16 be called "header data."

17 To enable distributed extension, the header data entries in header data 66
18 may include a "mandatory" attribute and/or an "actor" attribute. The mandatory
19 attribute indicates whether a header entry (i.e., header element) in the header data
20 is mandatory or optional for a recipient to process. The mandatory attribute may
21 also be called a "mustUnderstand" attribute. The actor attribute specifies the
22 identity of the entity that is intended to process an associated header entry.

Using the Exemplary Message Exchanger for RPC

One of the applications of the exemplary message exchanger is to encapsulate and exchange RPC calls using the extensibility and flexibility of XML. In the case of using HTTP as the protocol binding, an RPC call maps naturally to an HTTP request and a RPC response maps to an HTTP response. However, using the exemplary message exchanger for RPC is not limited to the HTTP protocol binding.

To make a RPC method call (i.e., "method invocation") using the exemplary message exchanger, the following information is typically provided within a message:

- The URI of the target object (i.e., name of and reference to the destination entity)
- A method name (i.e., task to be performed)
- The parameters to the method
- Optional header data

1 The information for the RPC method calls and responses are placed within
2 the body of the message. Such calls and responses are encoded into the body data
3 as follows:

- 4 • The method name is the first immediate child element of the body
5 data.
- 6 • Method parameters ([in] and [in/out] for a request, [in/out] and [out]
7 for a response) are each encoded as child elements of the method
8 name element using the following rules:
 - 9 ○ The name of the parameter in the method signature is used as
10 the name of the corresponding element.
 - 11 ○ Parameter values are expressed using specific rules.

12 13 **RPC and Header**

14 An example of a use of the header element is the passing of a transaction ID
15 along with a message. Since the transaction ID is not part of the method signature
16 and is typically held in an infrastructure component rather than in the application
17 code, there typically is no direct way to pass the necessary information with the
18 call. By adding an entry to the headers and giving it a fixed name, the transaction
19 manager on the receiving entity can extract the transaction ID and use it without
20 affecting the coding of remote procedure calls.

Exemplary Methodological Implementation of the Message Exchanger

Figs. 3 and 4 show an exemplary methodological implementation of the message exchanger. An originating entity (such as an application within computer 22 in Fig. 1) has a need to send a message across a message-oriented, decentralized, distributed network environment to a destination entity (such as an application within computer 24 in Fig. 1). That message may be a request for the destination entity to store data, a request for the destination entity to perform a task, a query regarding information to which the destination entity has access, or a data structure.

At 100 in Fig. 3, the originating entity generates message intended for the destination entity. In so doing, the originating entity formats the message in accordance with the format shown in Fig. 2. The details of block 100 are shown in Fig. 4 and discussed next.

At 250 of Fig. 4, the originating entity generates a message envelope with beginning and ending tags that identify the message envelope. This envelope and its tags are formatted like envelope 50 and tags 52, 54 in Fig. 2.

At 252 of Fig. 4, the originating entity generates a header with beginning and ending tags that identify the header. The header is placed between the envelope tags and immediately after the beginning envelope tag. This header and its tags are formatted like header 60 and tags 62, 64 in Fig. 2.

At 254 of Fig. 4, the originating entity generates a body with beginning and ending tags that identify the body. The body is placed between the envelope tags and immediately after the ending header tag. This body and its tags are formatted like body 70 and tags 72, 74 in Fig. 2.

At 256 of Fig. 4, the originating entity inserts the header data into the header between the header tags. At 258 of Fig. 4, the originating entity inserts the body data into the body between the body tags. Of course, the order that blocks 250-258 are processed is not important so much as their relative positioning (i.e., format) within the resulting message.

Returning to the discussion of the main messaging process shown in Fig. 3, the message is bound to a protocol at 102. Specifically, the originating entity binds the message to HTTP for transmission over the Internet. At 104, the originating entity transmits the HTTP-bound message to the destination entity over the Internet. This message will, most likely, travel through several intermediate entities. The intermediate entities may or may not examine at the contents of the message. Although an intermediate entity may not be the destination entity, it may be a receiving entity since it receives the message.

At 106, the destination entity receives the message. At 108, the destination entity parses the message. To accomplish this, the destination entity knows the designated format of the message *a priori*. In other words, destination entity parses the message assuming that it is in a specific format (in particular, in the format shown in Fig. 2). Alternatively, there may be information in the envelope tags that indicates the format of the message. This information may be the name of a format or a reference to storage location on the network that contains the format definition.

At 109, the destination entity determines whether the header has a mandatory attribute and if so, whether it is understood. If the mandatory header is not understood, then it returns a fault response at 110. Otherwise, the process continues to block 111.

At 111, the destination entity determines if the message requests the entity to perform a task. If so, the entity performs the requested task at 112.

After blocks 111 and 112, the destination entity determines if the message requires a response at 114. If it does, then the destination entity responds accordingly at 116. To respond, the destination entity generates and formats a new message containing the appropriate response. Thus, for the response the destination entity becomes the originating entity and vice versa. The above-describe process is performed to send a response from the original destination entity to the original originating entity.

The process ends at 118.

Mandatory Attribute

A mandatory attribute indicates whether a header entry in the header data is mandatory or optional for the recipient to process. The mandatory attribute is also called a “mustUnderstand” attribute. The recipient of a header entry is typically specified by an actor attribute (which is discussed below).

In the exemplary implementation, the mandatory attribute has the following label “mustUnderstand”. This attribute is either “1” meaning “yes” or “0” meaning “no”. The absence of the mandatory attribute is semantically equivalent to its presence with the value “0”.

If a header element is tagged with a mandatory attribute with a value of “1”, the recipient of that header entry either obeys the semantics (as conveyed by its element name, contextual setting, and so on) and takes the action indicated by the semantics, or it fails processing the message.

1 In the exemplary message exchanger, use of a mandatory attribute allows
2 for robust evolution. Elements tagged with the mandatory attribute with a value of
3 "1" are presumed to somehow modify the semantics of their parent or peer
4 elements. Tagging elements in this manner assures that this change in semantics
5 will not be silently (and, presumably, erroneously) ignored by those entities that
6 may not fully understand it.

7 Below is an example of a header with a label of "Transaction", a mandatory
8 attribute called "mustUnderstand" turned on (by setting it to "1") and a value of 5:

```
9      <SOAP-ENV:Header>  
10        <t:Transaction  
11          xmlns:t="some-URI" SOAP-ENV:mustUnderstand="1">  
12            5  
13          </t:Transaction>  
14        </SOAP-ENV:Header>
```

15 In addition, the mandatory attribute may also be inserted into the body data
16 to further identify the destination entity.

17 The entity that examines and processes the mandatory attribute is
18 determined by the actor attribute, discussed below.

19 Actor Attribute

20 The message travels from the originator to the ultimate destination
21 potentially by passing through a set of intermediaries along the message path. An
22 intermediary is an entity that is capable of both receiving and forwarding the
23 messages, but it is not the intended destination. Both intermediaries as well as the
24 ultimate destination may be identified by a URI (Universal Resource Identifier).
25

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1 The actor attribute specifies and identifies the intended recipient of a header
2 element. Omission of the actor attribute indicates that the sender is unconcerned
3 about which entity should process the header element. The actor attribute is used
4 to identify the entity that is going to act on that header element.

5 Not all parts of the message may be intended for the ultimate destination of
6 the message but may be intended for one or more of the intermediaries on the
7 message path. Specifically, a header element (directed to the recipient) may be
8 intended for an intermediary. The role of a recipient of a header element (directed
9 to the recipient) is similar to that of accepting a contract in that it cannot be
10 extended beyond the recipient. That is, a recipient receiving a header element does
11 not forward that header element to the next application in the message path. The
12 recipient may insert a similar header element but in that case, the contract is
13 between that intermediary and the recipient of that header element.

Alternative Methodological Implementation of the Exemplary Message

Exchanger

In an alternative exemplary methodological implementation of the message exchanger, an entity receiving a message does not know whom the message is intended for. Although the message is not intended for the receiving entity, a portion in the header may be intended for it. The actor attribute in the header may identify the receiving entity as the intended recipient for a specific portion of the header. Therefore, a receiving entity examines the header of a message to determine how to handle the message. More specifically, the receiving entity may be an “actor” entity that acts on part of the header.

At 270 in Fig. 5, an entity receives a message formatted in accordance with the message format shown in Fig. 2. This entity is any intermediate entity. At 272, the intermediate entity examines the header. At 274, the entity determines if one of the elements in the header data has an actor attribute directed towards the entity itself. If not, then the message is forwarded to the destination entity at 284.

If so, then, at 275, the intermediate entity (now called the “actor” entity) determines if there is a mandatory attribute that it must understand. If there is such an attribute and it does not understand it, then it returns a fault response at 286 and forwards the message to the destination entity at 284.

If the heading includes a mandatory attribute and the actor entity understands it, the actor entity acts in accordance with the semantics of the contents of the header element. In other words, the contents of the header element either directs the entity to perform some task and/or provides data for the entity to perform some presumed task. That task might be to respond. If so, then the entity responds at 278. At 280 and 282, the actor entity removes the header

1 directed at it and (optionally) replaces the header with a new one. After that, the
2 message is forwarded to the destination entity at 284.

3 In general, headers typically capture out-of-band data over which the
4 communicating entities have no prior agreement. There are two kinds of header
5 entries.

- 6 • End-to-end header entries such as those that capture transaction and
7 security contexts of the sender.
- 8 • Hop-to-hop header entries such as those that capture routing
9 information.

10 A header entry is either successfully understood and processed by an entity
11 or it is not. In the later case, it is an error only if the header entry has the
12 “mandatory” attribute set to “1”, in which case a “mustUnderstand” fault-response
13 is sent to the originating entity.

14 In the exemplary message exchanger, processing a header entry does not
15 typically involve generating other kinds of response to the originating entity, but it
16 may. But it may in alternative implementations. In addition, in the exemplary
17 message exchanger, successful processing a header entry does not necessarily
18 result in its removal and similarly, removal of a header entry does not necessarily
19 result in addition of a new entry. But it may in alternative implementations.

Fault Message

If an intermediate entity for which it is the actor (i.e., an “actor” entity) does not understand a mandatory element of a message or if a receiving entity encounters a problem in processing the message (or its requested task), then the receiving entity sends a response message that includes an error indication. This is called a “fault message.”

The fault message is generated, formatted, and sent in the same manner described above for any message. In this case, the message is sent in response to another message and the body of the message includes an error indication (i.e., “fault element”).

A fault element typically has four subelements:

- faultcode
- faultstring
- faultactor
- detail

The faultcode subelement is intended for use by an entity to provide an algorithmic mechanism for identifying the fault. The exemplary message exchanger defines a small set of the fault codes covering basic the message exchange faults.

The faultstring subelement is intended to provide a human readable explanation of the fault and is not intended for algorithmic processing. The faultstring element is similar to the 'Reason-Phrase' defined by HTTP.

The faultactor subelement is intended to provide information about which receiving entity caused the fault to happen within the message path. It is similar to the actor attribute but instead of indicating the destination of a header entry, it

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1 indicates the source of the fault. The value of the faultactor attribute is a URI
2 identifying the source.

3 The detail subelement is intended for carrying application specific error
4 information related to the body element. The absence of the detail subelement in
5 the fault element indicates that the fault is not related to processing of the body
6 data. This can be used to distinguish whether the body data was processed or not
7 in case of a fault situation.

8 9 **Using the Exemplary Message Exchanger in HTTP**

10 Binding a message to HTTP provides the advantage of being able to use the
11 formalism and decentralized flexibility of the exemplary message exchanger with
12 the rich feature set of HTTP. Carrying the message in HTTP does not mean that
13 the message overrides existing semantics of HTTP but rather that the semantics of
14 the message sent over HTTP maps naturally to HTTP semantics.

15 The exemplary message exchanger naturally follows the HTTP
16 request/response message model providing the message request parameters in a
17 HTTP request and the message response parameters in a HTTP response.

18 HTTP applications use the media type "text/xml" when including a
19 message envelope in a HTTP message.

20 HTTP Request: Although any of HTTP request methods may be used, this
21 exemplary implementation sends HTTP-bound messages within an HTTP POST
22 requests.

23 Action HTTP Header Field: An action HTTP header field may be used to
24 indicate the intent of an HTTP-bound message in an HTTP request. The presence
25

and content of the action header field may be used by servers (such as firewalls) to appropriately filter an HTTP-bound message in an HTTP request.

HTTP Response: An HTTP-bound message follows the semantics of the HTTP status codes for communicating status information in HTTP. For example, a 2xx status code indicates that the client's request including the message component was successfully received, understood, and accepted etc.

In case of an error while processing the request, the HTTP server issues an HTTP 500 "Internal Server Error" response and include a message in the response containing a fault element indicating the processing error.

HTTP Extension Framework: A message may be used together with the HTTP Extension Framework in order to identify the presence and intent of a HTTP-bound message in an HTTP request.

A specific implementation may use either the Extension Framework or plain HTTP. Clients can force the use of the HTTP Extension Framework by using a mandatory extension declaration and the "M-" HTTP method name prefix. Servers can force the use of the HTTP Extension Framework by using the 510 "Not Extended" HTTP status code. That is, using one extra round trip, either party can detect the policy of the other party and act accordingly.

Examples of the Messages Exchanged Using the Exemplary Message

Exchanger

In the following examples, a GetLastTradePrice request is sent to a StockQuote service. The request takes a string parameter, ticker, and returns a float in a response.

Example 1:

```
POST /StockQuote HTTP/1.1
Host: www.stockquoteserver.com
Content-Type: text/xml
Content-Length: nnnn
SOAP Action: "Some-URI "

<SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Header>
    <t:Transaction
      xmlns:t="some-URI "
      SOAP-ENV:mustUnderstand="1">
      5
    </t:Transaction>
  </SOAP-ENV:Header>
  <SOAP-ENV:Body>
    <m:GetLastTradePrice xmlns:m="Some-URI">
      <symbol>DEF</symbol>
    </m:GetLastTradePrice>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Example 2:

```
HTTP/1.1 200 OK
Content-Type: text/xml
Content-Length: nnnn

<SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Header>
    <t:Transaction
      xmlns:t="some-URI "
      xsi:type="int" mustUnderstand="1">
```

```

5
    </t:Transaction>
1  </SOAP-ENV:Header>
    <SOAP-ENV:Body>
2      <m:GetLastTradePriceResponse
        xmlns:m="Some-URI">
3          <Price>34.5</Price>
        </m:GetLastTradePriceResponse>
    </SOAP-ENV:Body>
4 </SOAP-ENV:Envelope>

```

Example 3:

```

7 HTTP/1.1 500 Internal Server Error
8 Content-Type: text/xml
Content-Length: nnnn

9 <SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
10   <SOAP-ENV:Body>
11     <SOAP-ENV:Fault>
        <faultcode>MustUnderstand</faultcode>
        <faultstring>the exemplary message exchanger Must Understand
Error</faultstring>
12     </SOAP-ENV:Fault>
    </SOAP-ENV:Body>
13 </SOAP-ENV:Envelope>

```

Example 4:

```

16 HTTP/1.1 500 Internal Server Error
Content-Type: text/xml
Content-Length: nnnn

18 <SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
    <SOAP-ENV:Body>
19      <SOAP-ENV:Fault>
        <faultcode>Server</faultcode>
        <faultstring>Server Error</faultstring>
        <detail>
20          <e:myfaultdetails xmlns:e="Some-URI">
            <message>
21              My application didn't work
            </message>
            <errorcode>
22              1001
            </errorcode>
23          </e:myfaultdetails>
        </detail>
        </SOAP-ENV:Fault>
24    </SOAP-ENV:Body>
25 </SOAP-ENV:Envelope>

```

Exemplary Computing Environment

Fig. 6 illustrates an example of a suitable computing environment 920 on which the exemplary watermarking may be implemented.

Exemplary computing environment 920 is only one example of a suitable computing environment and is not intended to suggest any limitation as to the scope of use or functionality of the exemplary message exchanger. Neither should the computing environment 920 be interpreted as having any dependency or requirement relating to any one or combination of components illustrated in the exemplary computing environment 920.

The exemplary message exchanger is operational with numerous other general purpose or special purpose computing system environments or configurations. Examples of well known computing systems, environments, and/or configurations that may be suitable for use with the exemplary message exchanger include, but are not limited to, personal computers, server computers, thin clients, thick clients, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, wireless phones, wireless communications equipment, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

The exemplary message exchanger may be described in the general context of computer-executable instructions, such as program modules, being executed by a computer. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. The exemplary message exchanger may also be

1 practiced in distributed computing environments where tasks are performed by
2 remote processing devices that are linked through a communications network. In
3 a distributed computing environment, program modules may be located in both
4 local and remote computer storage media including memory storage devices.

5 As shown in Fig. 6, the computing environment 920 includes a general-
6 purpose computing device in the form of a computer 930. The components of
7 computer 920 may include, by are not limited to, one or more processors or
8 processing units 932, a system memory 934, and a bus 936 that couples various
9 system components including the system memory 934 to the processor 932.

10 Bus 936 represents one or more of any of several types of bus structures,
11 including a memory bus or memory controller, a peripheral bus, an accelerated
12 graphics port, and a processor or local bus using any of a variety of bus
13 architectures. By way of example, and not limitation, such architectures include
14 Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA)
15 bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA)
16 local bus, and Peripheral Component Interconnects (PCI) bus also known as
17 Mezzanine bus.

18 Computer 930 typically includes a variety of computer readable media.
19 Such media may be any available media that is accessible by computer 930, and it
20 includes both volatile and non-volatile media, removable and non-removable
21 media.

22 In Fig. 6, the system memory includes computer readable media in the form
23 of volatile memory, such as random access memory (RAM) 940, and/or non-
24 volatile memory, such as read only memory (ROM) 938. A basic input/output
25 system (BIOS) 942, containing the basic routines that help to transfer information

1 between elements within computer 930, such as during start-up, is stored in ROM
2 938. RAM 940 typically contains data and/or program modules that are
3 immediately accessible to and/or presently be operated on by processor 932.

4 Computer 930 may further include other removable/non-removable,
5 volatile/non-volatile computer storage media. By way of example only, Fig. 6
6 illustrates a hard disk drive 944 for reading from and writing to a non-removable,
7 non-volatile magnetic media (not shown and typically called a "hard drive"), a
8 magnetic disk drive 946 for reading from and writing to a removable, non-volatile
9 magnetic disk 948 (e.g., a "floppy disk"), and an optical disk drive 950 for reading
10 from or writing to a removable, non-volatile optical disk 952 such as a CD-ROM,
11 DVD-ROM or other optical media. The hard disk drive 944, magnetic disk drive
12 946, and optical disk drive 950 are each connected to bus 936 by one or more
13 interfaces 954.

14 The drives and their associated computer-readable media provide
15 nonvolatile storage of computer readable instructions, data structures, program
16 modules, and other data for computer 930. Although the exemplary environment
17 described herein employs a hard disk, a removable magnetic disk 948 and a
18 removable optical disk 952, it should be appreciated by those skilled in the art that
19 other types of computer readable media which can store data that is accessible by a
20 computer, such as magnetic cassettes, flash memory cards, digital video disks,
21 random access memories (RAMs), read only memories (ROM), and the like, may
22 also be used in the exemplary operating environment.

23 A number of program modules may be stored on the hard disk, magnetic
24 disk 948, optical disk 952, ROM 938, or RAM 940, including, by way of example,
25

1 and not limitation, an operating system 958, one or more application programs
2 960, other program modules 962, and program data 964.

3 A user may enter commands and information into computer 930 through
4 input devices such as keyboard 966 and pointing device 968 (such as a "mouse").
5 Other input devices (not shown) may include a microphone, joystick, game pad,
6 satellite dish, serial port, scanner, or the like. These and other input devices are
7 connected to the processing unit 932 through an user input interface 970 that is
8 coupled to bus 936, but may be connected by other interface and bus structures,
9 such as a parallel port, game port, or a universal serial bus (USB).

10 A monitor 972 or other type of display device is also connected to bus 936
11 via an interface, such as a video adapter 974. In addition to the monitor, personal
12 computers typically include other peripheral output devices (not shown), such as
13 speakers and printers, which may be connected through output peripheral interface
14 975.

15 Computer 930 may operate in a networked environment using logical
16 connections to one or more remote computers, such as a remote computer 982.
17 Remote computer 982 may include many or all of the elements and features
18 described herein relative to computer 930.

19 Logical connections shown in Fig. 6 are a local area network (LAN) 977
20 and a general wide area network (WAN) 979. Such networking environments are
21 commonplace in offices, enterprise-wide computer networks, intranets, and the
22 Internet.

23 When used in a LAN networking environment, the computer 930 is
24 connected to LAN 977 network interface or adapter 986. When used in a WAN
25 networking environment, the computer typically includes a modem 978 or other

1 means for establishing communications over the WAN 979. The modem 978,
2 which may be internal or external, may be connected to the system bus 936 via the
3 user input interface 970, or other appropriate mechanism.

4 Depicted in Fig. 6, is a specific implementation of a WAN via the Internet.
5 Over the Internet, computer 930 typically includes a modem 978 or other means
6 for establishing communications over the Internet 980. Modem 978, which may
7 be internal or external, is connected to bus 936 via interface 970.

8 In a networked environment, program modules depicted relative to the
9 personal computer 930, or portions thereof, may be stored in a remote memory
10 storage device. By way of example, and not limitation, Fig. 6 illustrates remote
11 application programs 989 as residing on a memory device of remote computer
12 982. It will be appreciated that the network connections shown and described are
13 exemplary and other means of establishing a communications link between the
14 computers may be used.

15 16 **Exemplary Operating Environment**

17 Fig. 6 illustrates an example of a suitable operating environment 920 in
18 which the exemplary message exchanger may be implemented. Specifically, the
19 exemplary message exchanger is implemented by any program 960-962 or
20 operating system 958 in Fig. 6.

21 The operating environment is only an example of a suitable operating
22 environment and is not intended to suggest any limitation as to the scope of use of
23 functionality of the exemplary message exchanger described herein. Other well
24 known computing systems, environments, and/or configurations that may be
25 suitable for use with the exemplary message exchanger include, but are not limited

1 to, personal computers, server computers, hand-held or laptop devices,
2 multiprocessor systems, microprocessor-based systems, programmable consumer
3 electronics, network PCs, minicomputers, mainframe computers, distributed
4 computing environments that include any of the above systems or devices, and the
5 like.

6 7 **Computer-Executable Instructions**

8 An implementation of the exemplary message exchanger may be described
9 in the general context of computer-executable instructions, such as program
10 modules, executed by one or more computers or other devices. Generally,
11 program modules include routines, programs, objects, components, data structures,
12 etc. that perform particular tasks or implement particular abstract data types.
13 Typically, the functionality of the program modules may be combined or
14 distributed as desired in various embodiments.

15 16 **Computer Readable Media**

17 An implementation of the exemplary message exchanger may be stored on
18 or transmitted across some form of computer readable media. Computer readable
19 media can be any available media that can be accessed by a computer. By way of
20 example, and not limitation, computer readable media may comprise computer
21 storage media and communications media.

22 Computer storage media include volatile and non-volatile, removable and
23 non-removable media implemented in any method or technology for storage of
24 information such as computer readable instructions, data structures, program
25 modules, or other data. Computer storage media includes, but is not limited to,

1 RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM,
2 digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic
3 tape, magnetic disk storage or other magnetic storage devices, or any other
4 medium which can be used to store the desired information and which can be
5 accessed by a computer.

6 Communication media typically embodies computer readable instructions,
7 data structures, program modules, or other data in a modulated data signal such as
8 carrier wave or other transport mechanism and included any information delivery
9 media. The term "modulated data signal" means a signal that has one or more of
10 its characteristics set or changed in such a manner as to encode information in the
11 signal. By way of example, and not limitation, communication media includes
12 wired media such as a wired network or direct-wired connection, and wireless
13 media such as acoustic, RF, infrared, and other wireless media. Combinations of
14 any of the above are also included within the scope of computer readable media.

15 16 Conclusion

17 Although the message exchanger has been described in language specific to
18 structural features and/or methodological steps, it is to be understood that the
19 message exchanger defined in the appended claims is not necessarily limited to the
20 specific features or steps described. Rather, the specific features and steps are
21 disclosed as preferred forms of implementing the claimed message exchanger.